

# **Storage of Ammunition in an Operational Environment from a Belgian perspective**

## **Authors:**

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## **Session**

*Suggestion: Explosives Safety in Contingency & Combat Operations*

## **Paper**

### **1. Introduction**

Since the end of the cold war Belgium troops have been deployed in a number of theaters throughout the world. Today the focus of operations is on Afghanistan but smaller contingents are also present in areas like Lebanon and Central Africa.

Out of a total for the Armed Forces of approximately 35,000 people, about 1100 are deployed in an operational environment on a permanent basis, generally with 4 month rotations.

As far as the type of operations is concerned, Belgian troops consist mostly of light infantry, EOD specialists and engineers, often deployed in a multi-national environment (NATO, UN or EU flag). Air Force and Navy also participate with combat aircraft (F16) and frigates.

### **2. Ammunition Storage regulations**

The regulations Belgium applies for Ammunition Storage are mainly the North Atlantic Treaty Organization (NATO) Safety Principles for the Storage of military ammunition and explosives (STANAG 4440 Ed1 Ch3 , **AASTP-1**) and the guidelines for the Storage, Maintenance and Transport of Ammunition on Deployed Missions or Operations (STANAG 4657 Ed1, **AASTP-5**). For (military) airfield specific constructions (US) AFMAN 91-201 is used expect for external safety distances where AASTP-1 values are applicable due to the lower pressure threshold (5 kPa vs 8 kPa). Navy warships use their specific regulations once the vessel has left port.

### **3. Problems encountered**

In applying these regulations in the field a number of difficulties arise. First of all there is the potential conflict between the strictly operational and logistical requirements and ammunition storage requirements:

- Type of operation:
  - a low tension operation is generally less challenging for Ammo storage
  - a high tension operation is very challenging for Ammo storage, in a situation where the ammunition is the most needed
- Flexibility:
  - “temporary” installation vs. solid construction.

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- rapidly changing requirements need flexible storage solutions, but to which extent?
- Security: force protection is easier with less real estate whereas distance (QD/FD) is the best guarantee for explosive safety.
- Environment : accessibility & communication vs. ammunition storage in remote areas

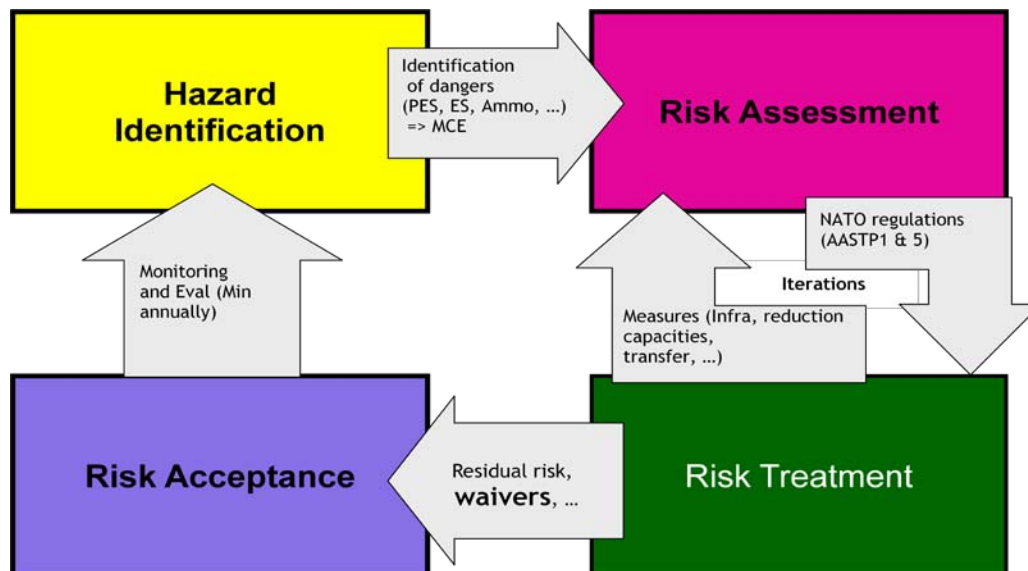
The most important problems encountered regarding the storage of ammunition during Belgian deployed missions over the last couple of years are:

- Short notice planning
- Rapidly changing situations
- Available real estate
- (lack of) Ammo specialists in Ops theater
- Information loss during rotations
- Working in multi-national environment is fun but challenging

To accelerate the response time all intermediate levels were eliminated and there is now a direct communication between the people in the field and the licensing authority.

#### 4. Risk management

The process to manage the risk is illustrated in the figure below. The monitoring and evaluation step has increased importance in an operational environment due to the rapidly changing situations and the relatively high frequency of rotations of personnel (generally every 4 months).



When regulations can't be met a risk assessment procedure is needed to determine if the residual risk is acceptable to the commander.

A NATO methodology for operational risk assessment for ammunition storage is currently under development within the NATO AC326 Ammunition Safety Working Group (SG6) and will enable to facilitate multi-national cooperation.

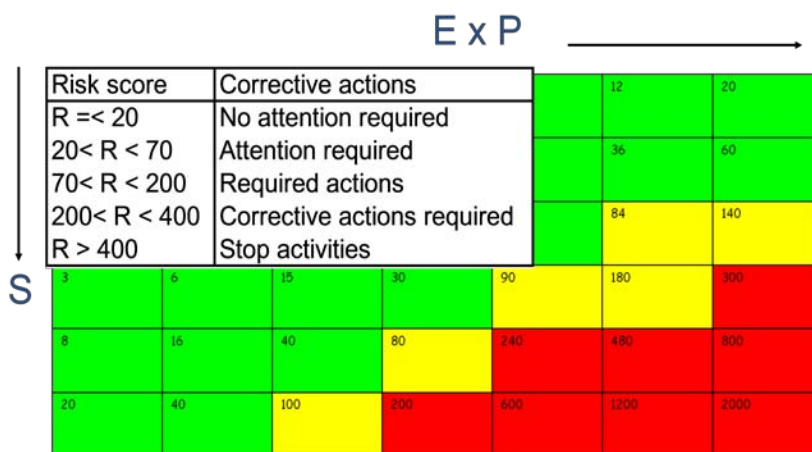
From a technical point of view especially the state of the art consequence analysis tool will be a huge improvement.

Belgium currently uses the Kinney risk analysis method to assess risk when regulations cannot be met. This is in line with this NATO AASTP-5 future risk assessment procedure. It gives the commander a simple and quick view of the impact of the ammunition storage risk on his mission capabilities and also allows to evaluate the effectiveness of proposed measures.

Kinney expresses risk as the product of 3 factors: severity (or consequence), probability and exposure. A value is attributed to each of these factors using the tables below, determining the overall risk level:

P	Probability	E	Exposure	S	Severity
P = 0.1 =	Highly unlikely	E = 0.5 =	Very rare	S = 1 =	Negligible injuries
P = 0.2 =	Practically impossible	E = 1 =	Rare	S = 3 =	Minor injuries
P = 0.5 =	Possible but unlikely	E = 2 =	Unusual	S = 7 =	Major injuries
P = 1 =	Unlikely	E = 3 =	Occasional	S = 15 =	Fatal ( 1 death )
P = 3 =	Likely	E = 6 =	Frequent	S = 40 =	Disaster, more than one death
P = 6 =	Very likely	E = 10 =	Continuous		

The overall risk can be graphically represented as in the figure below. For each particular case a description on how the mission capability is affected by the risk tied to the storage of ammunition is added to the risk score and the suggested corrective actions.



## 5. Examples of ammunition storage in theatre

Given the type of mission and troops deployed the most typical storage configuration for compounds consists of barricaded ISO-containers.

The following example describes the different steps showing the effects of the implemented mitigation measures on the overall risk result.

In the initial situation all the ammunition ISO-containers were stored unbarricaded on the « parade ground ». This resulted in a Maximum Credible Event (MCE) of X T NEQ and an overall Kinney score:  $R = 1000 = \text{unacceptable}$ .

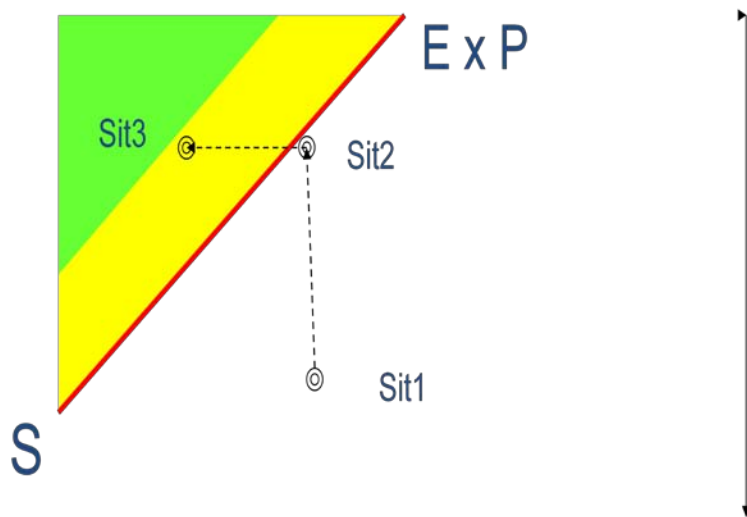
The MCE was reduced to  $\text{MCE} = X/40 \text{ NEQ}$  by transferring part of the ammunition to a nearby depot of another nation and by barricading the containers. Inside each container each pile of ammunition was also barricaded to prevent instant propagation from one pile to another.

This method was tested and validated during two trials in 2003 and 2004. The test results were published as an informal working paper for the Subgroup 6 of the NATO Ammunition Safety Group.

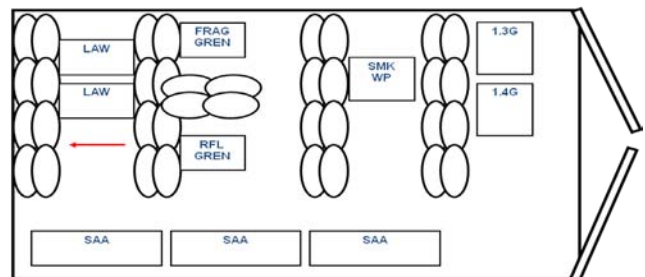
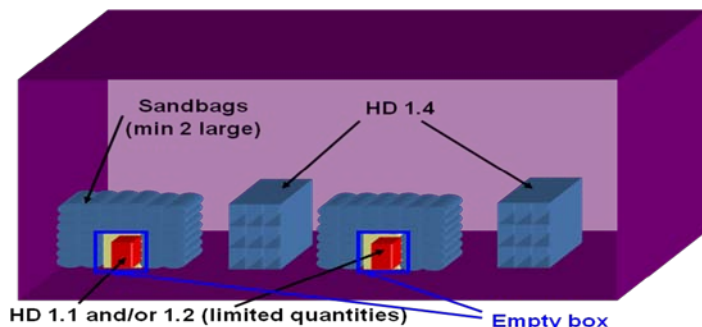
The overall Kinney score dropped to  $R=400=$  still unacceptable, but on the edge of the acceptable.

A part from working on the MCE the risk can also be reduced by working on the probability and exposure parameters. The effect of other measures such as temperature monitoring, having an ammunition technician as manager of the storage site further reduced the risk to  $R=80$ , within the ALARP region. This residual risk was accepted.

The figure below graphically represents the above described steps :



In recent years ISO-containers with internal barricades were frequently used in deployed operations in various areas of the world, as is illustrated by the pictures below:



As far as deployed operating bases for combat aircraft are concerned airfield specific constructions are not always in the same configuration as on their main operating base. Special consideration is given to barricades to prevent instant propagation from one Combat Aircraft Parking Area (CAPA) to another.

Initially concrete T-barriers were used to separate two CAPA's. From a Force Protection view this might be useful, but their effectiveness for explosive safety purposes was seriously doubted. It was decided to replace them by sand filled ISO-containers (a US approved structure as a barricade).



# Storage of Ammunition in an Operational Environment from a Belgian Perspective

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Risk Management

# Summary

- Introduction
- BEL Armed Forces : current Ops
- Regulations for storage of Ammunition in Ops
- Problems encountered
- Risk Management
- Examples
- Questions





# Introduction



Surface: 30,510 sq km (0.3% USA)

Population: 11 Mio

Armed Forces : +/- 35.000

Deployed in Ops : +/- 1.100 x 3/j

# BEL Armed Forces: current Ops

## Main Ops:

- Afghanistan (ISAF: KAIA, KAF, Kunduz, Mazar-e-Sharif)
- Libanon (BELUFIL)
- Central Africa (Congo, ...)
- Horn of Africa (NAVY)

## Type of Ops:

LAND: Light Infantry, Engineers, EOD, ...

AIR: Det F16

NAVY: shipping route protection (Frigate)



# Regulations

	LAND	AIR	NAVY
BE	AASTP-1 Ed1 Ch3	AASTP-1 Ed1 Ch3 (US) AFMAN 91-201 (airfield specific constructions) (*)	AASTP-1 Ed1 Ch3 (ports) DGMR-GID-DISPSYS- NFMX-001 (at sea)
Ops			
2nd line	AASTP-1 Ed1 Ch3	AASTP-1 Ed1 Ch3 (US) AFMAN 91-201 (airfield specific constructions) (*)	AASTP-1 Ed1 Ch3 (ports) DGMR-GID-DISPSYS- NFMX-001 (at sea)
FOB, compound	AASTP-5 Ed1	N/A	N/A

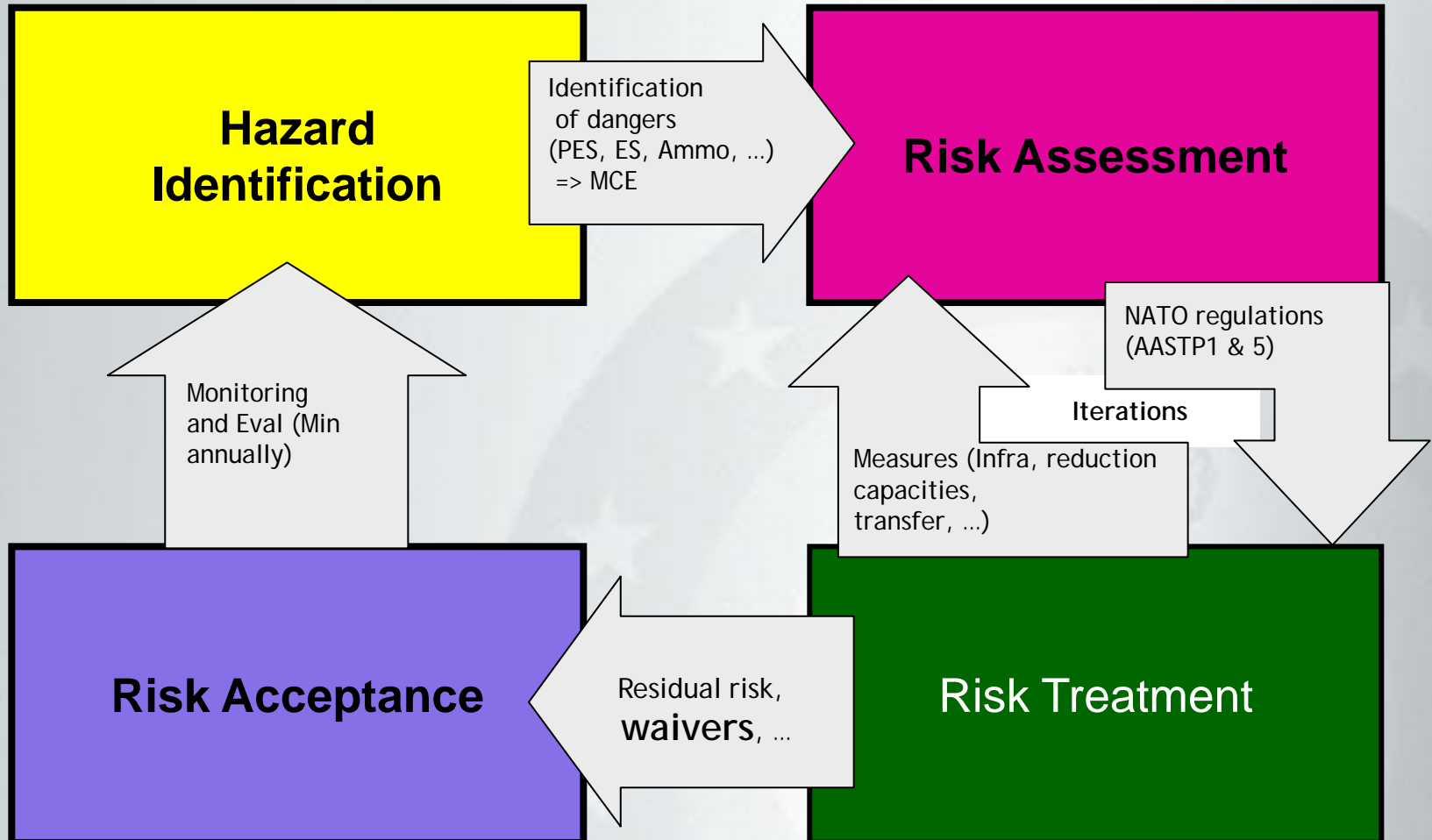
- NATO Safety Principles for the Storage of military ammunition and explosives (STANAG 4440 Ed1 Ch3 , **AASTP-1**)
- NATO Guidelines for the Storage, Maintenance and Transport of Ammunition on Deployed Missions or Operations (STANAG 4657 Ed1, **AASTP-5**)
- (\*) External : AASTP-1 values due to lower pressure threshold (5 kPa vs 8 kPa)

# Problems encountered

- Short notice planning
- Rapidly changing situations
- Available real estate
- (lack of) Ammo specialists in Ops theatre
- Information loss during rotations
- Working in multi-national environment is fun but challenging

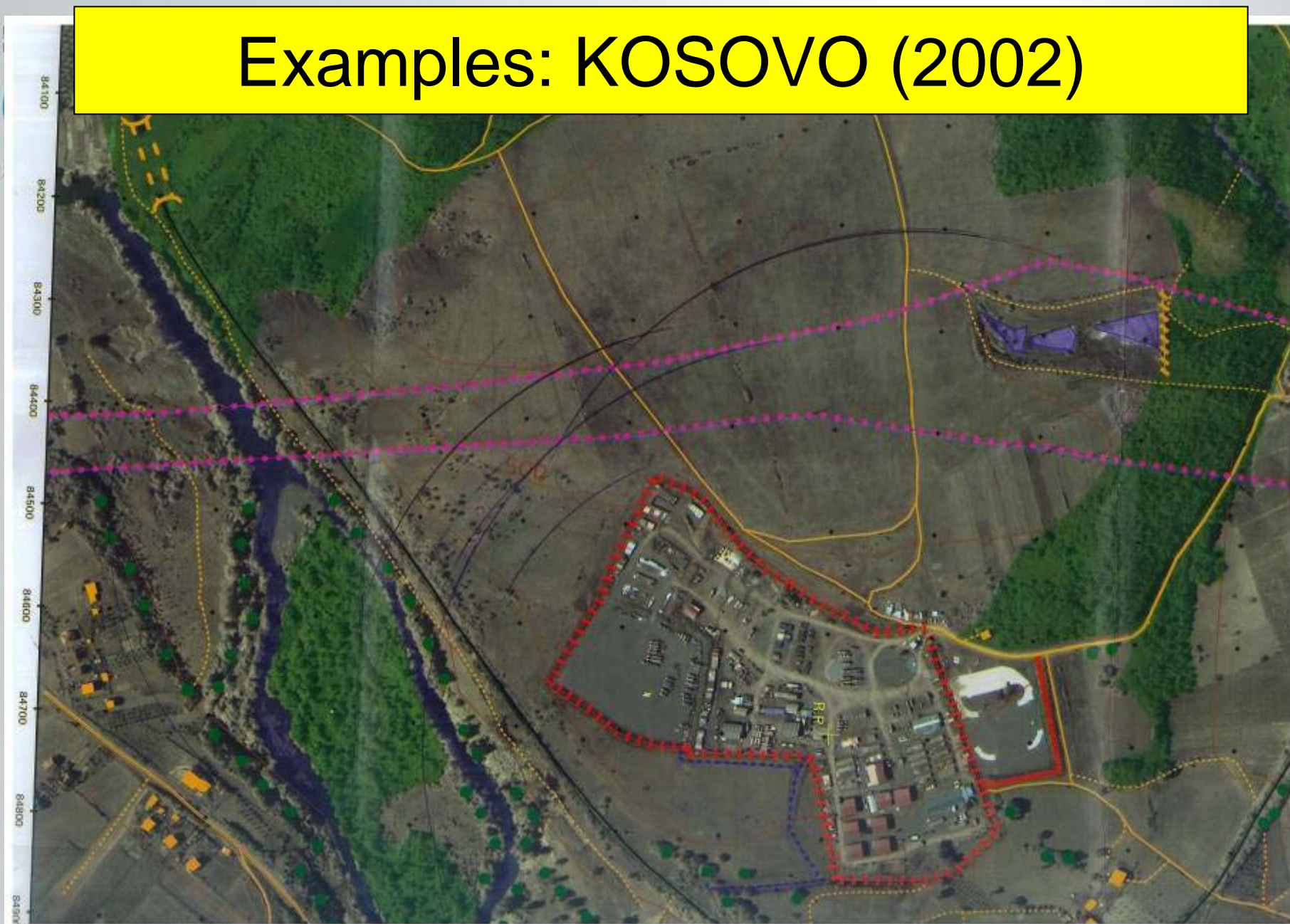


# Risk Management

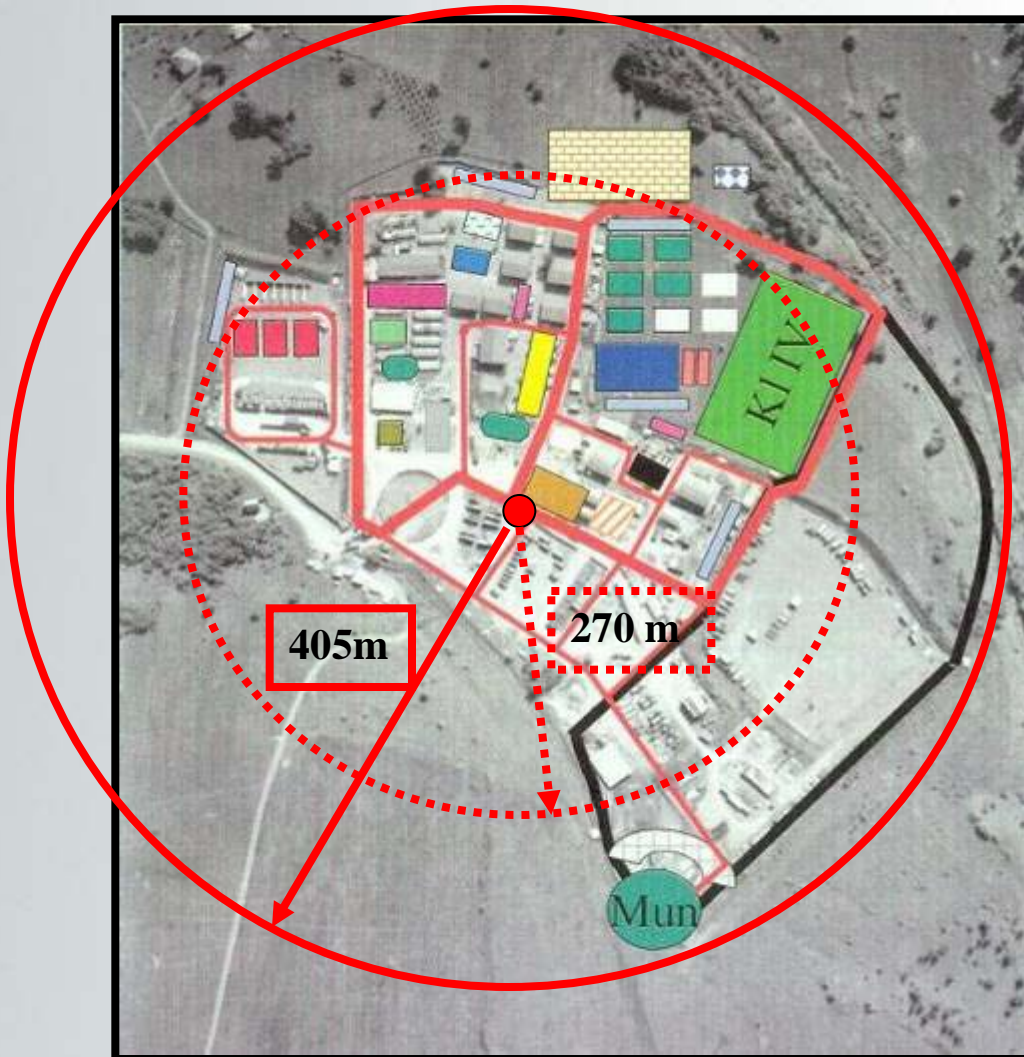




# Examples: KOSOVO (2002)



# Examples: KOSOVO (2002)







When regulations can not be met

# Risk assessment: Kinney

**Risk = Severity x Exposure x Probability**

- Severity of injury linked to hazard
- Exposure to the hazard
- Probability of the hazard to occur when exposed

P	Probability	E	Exposure	S	Severity
P = 0.1 =	Highly unlikely	E = 0.5 =	Very rare	S = 1 =	Negligible injuries
P = 0.2 =	Practically impossible	E = 1 =	Rare	S = 3 =	Minor injuries
P = 0.5 =	Possible but unlikely	E = 2 =	Unusual	S = 7 =	Major injuries
P = 1 =	Unlikely	E = 3 =	Occasional	S = 15 =	Fatal ( 1 death )
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When regulations can not be met

# Risk assessment: Kinney

E x P

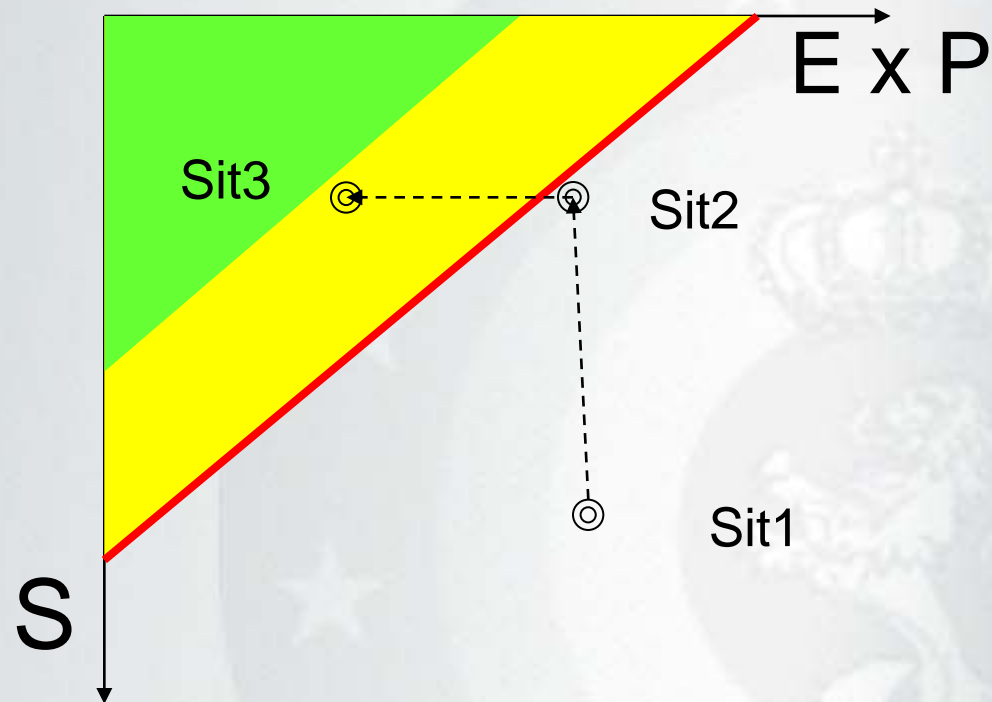


S ↓	Risk score		Corrective actions			12	20
	R ≤ 20		No attention required				
	20 < R < 70		Attention required			36	60
	70 < R < 200		Required actions				
	200 < R < 400		Corrective actions required			84	140
	R > 400		Stop activities				
	5	8	16	30	90	180	300
	8	16	40	80	240	480	800
	20	40	100	200	600	1200	2000

In line with NATO AASTP-5 future risk assessment procedure

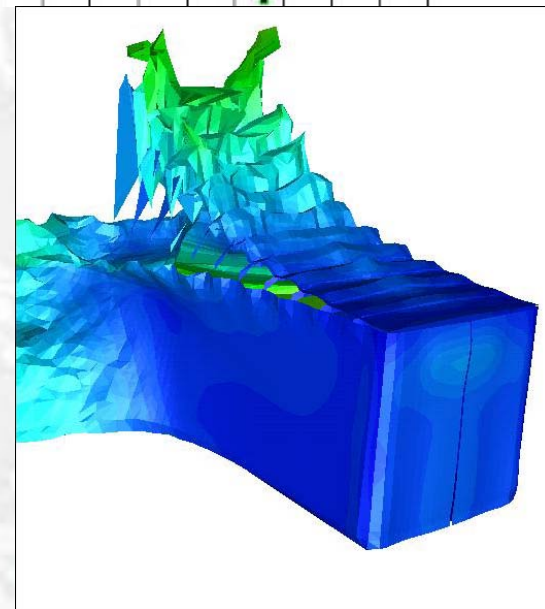
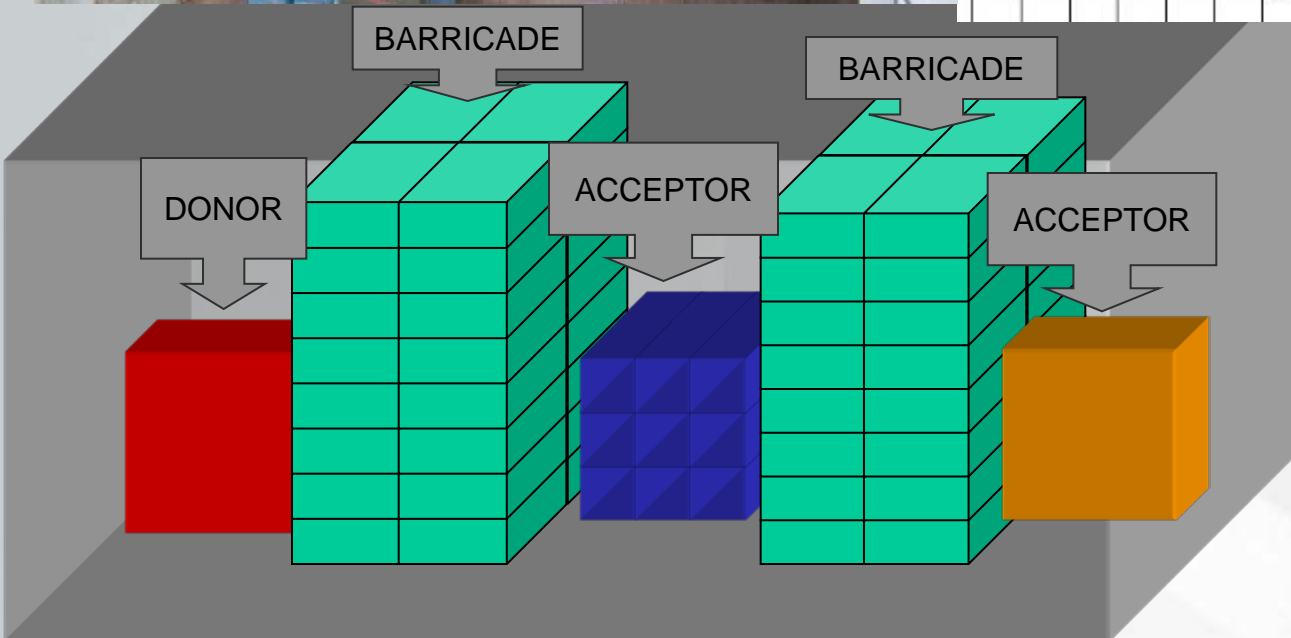
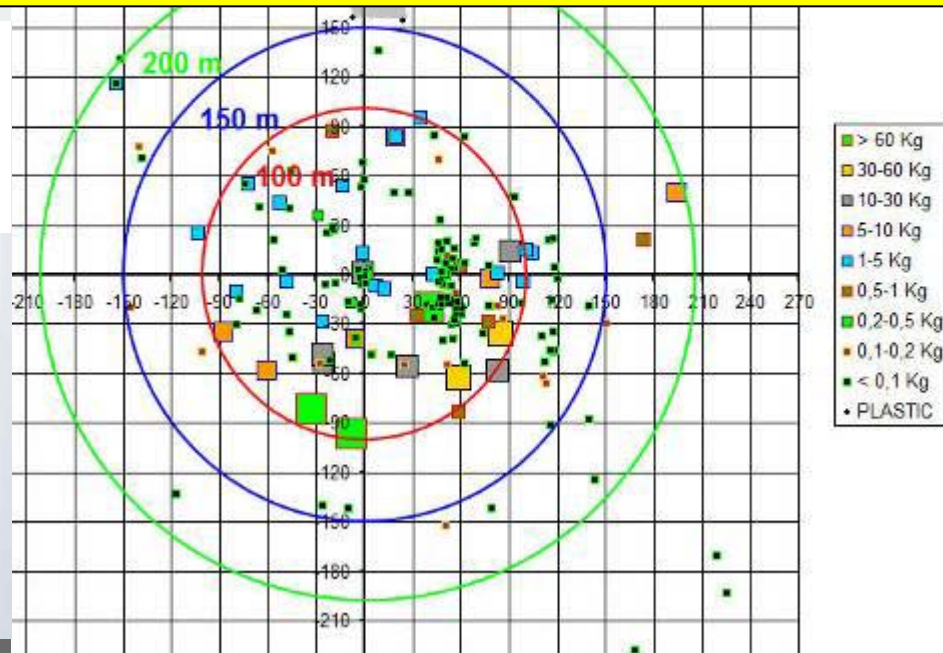
# Example of risk assessment in Ops

1.  $MCE = X T NEQ$  « parade ground » Kinney:  $R=1000$ = unacceptable
2.  $MCE = X/40 NEQ$  (by transfer to other nations site and barricades around/inside container) Kinney:  $R=400$ = unacceptable
3. Effect of other measures (Qualif Pers, ...) Kinney:  $R=80$ =ALARP

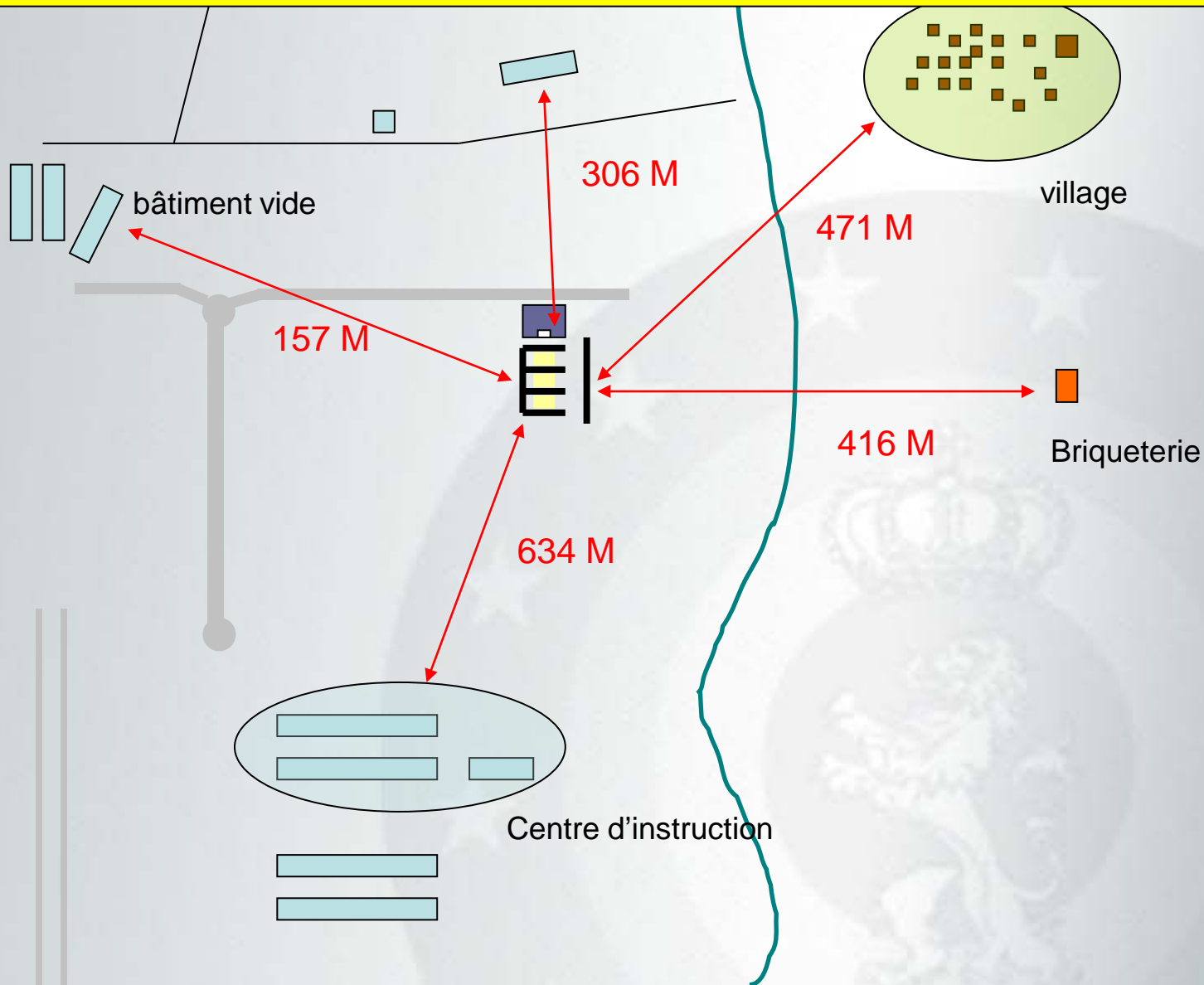


# Reduction MCE by barricades inside container

Use of barricades inside container for reduction of maximum credible event (MCE), tested in 2003/4

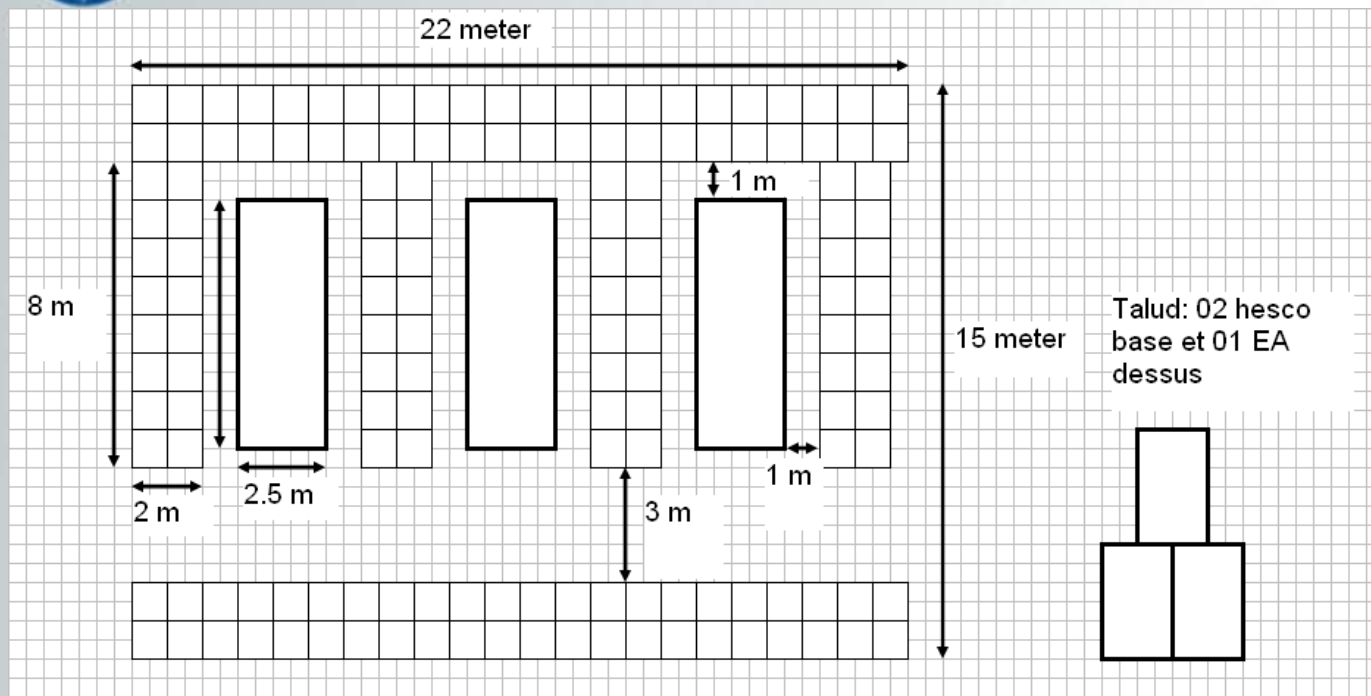


# Examples : compound configuration





# Examples : compound configuration



Cordet : 2 bx  
TNT 500 : 2 bx  
Safe : 4 RI

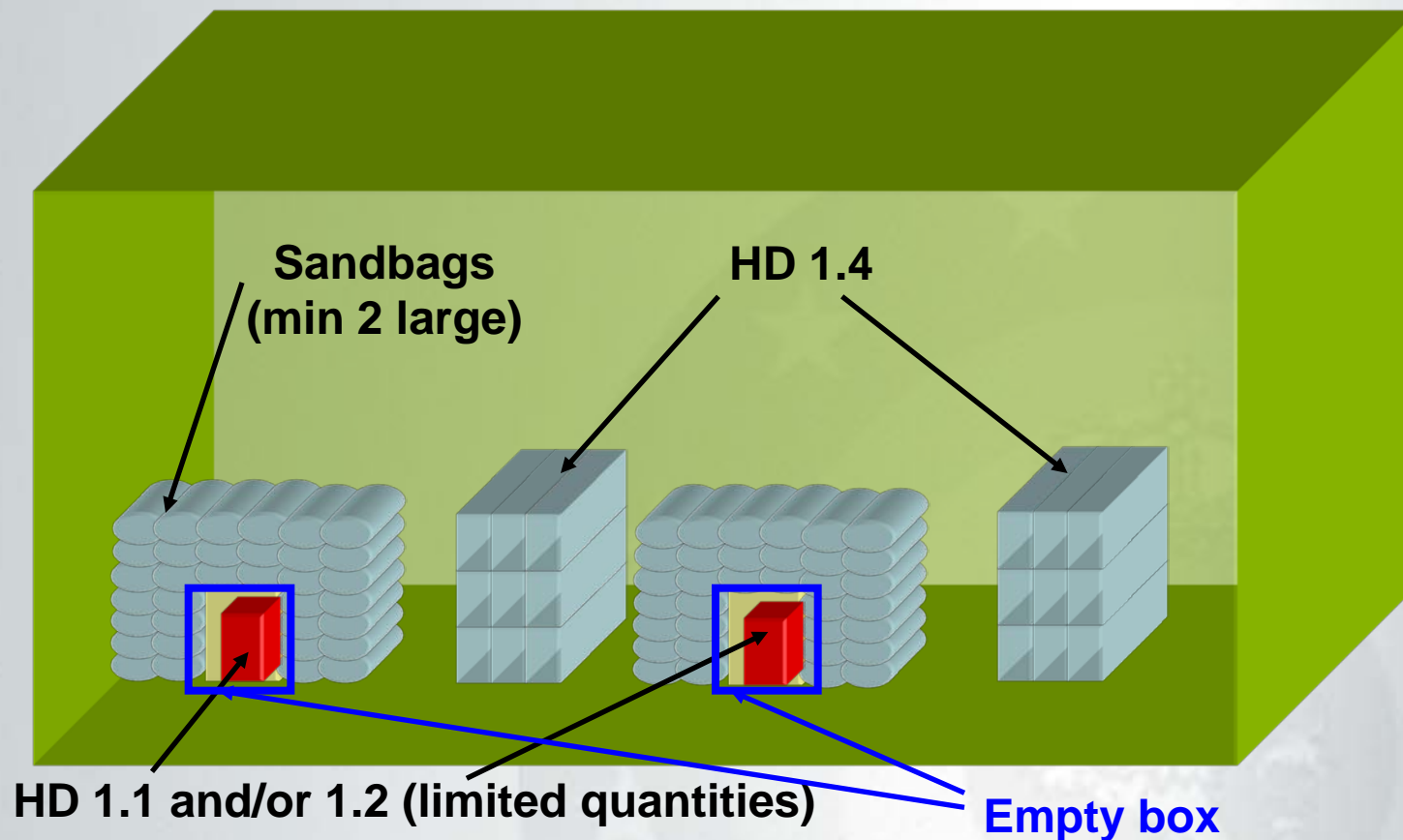
Cordet : 2 bx  
TNT 250 : 2 bx  
Safe : 4 RI

Cordet : 2 bx  
TNT 100 : 2 bx  
Safe : 4 RI  
Elec det PRAC

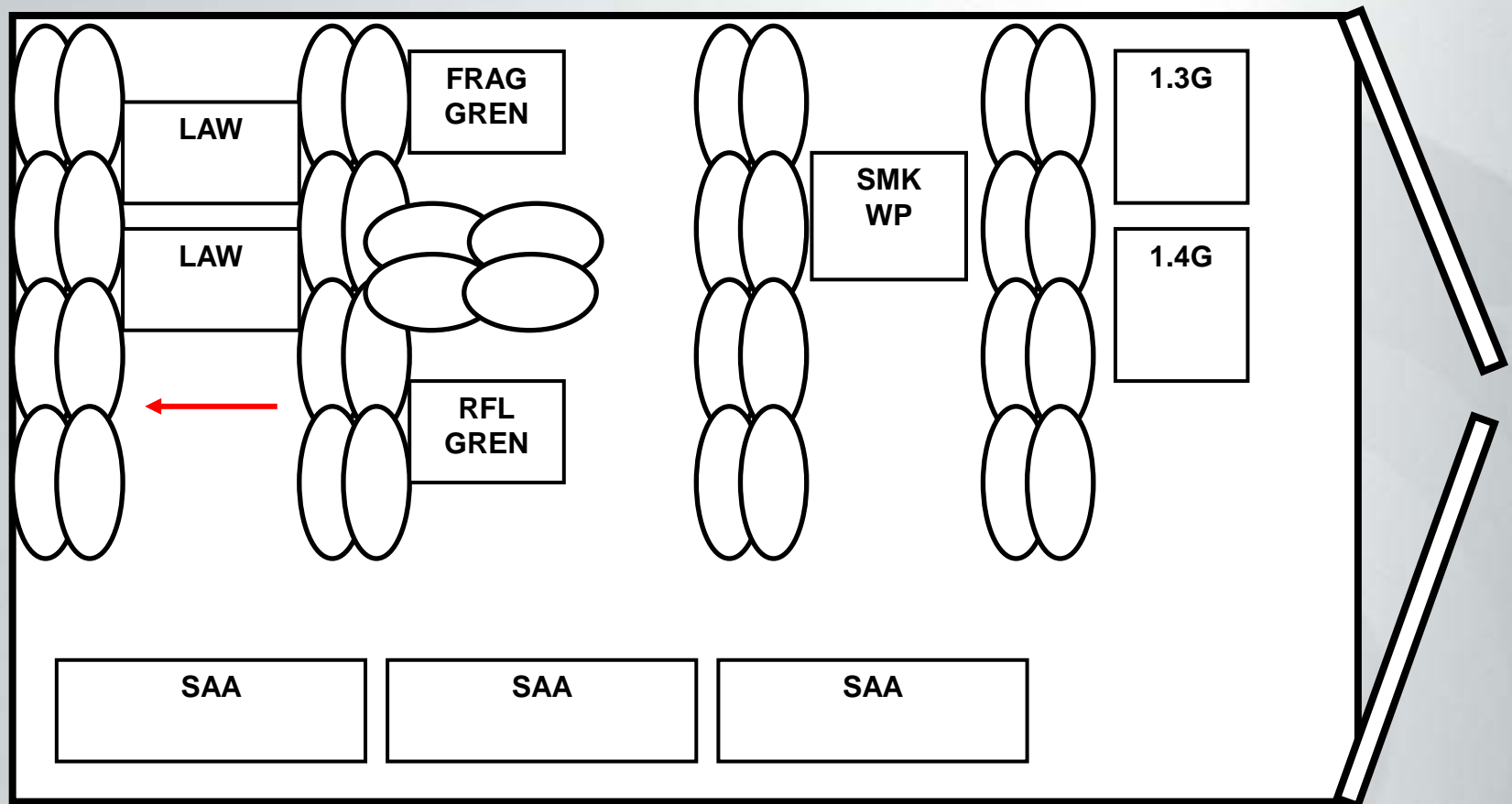
Cordet : 1 RL  
TNT 100 : 3 bx  
Safe : 4 RI  
Cart PRAC

Container n°1

# Examples : compound configuration



# Examples : compound configuration





# Examples: compound configuration







# Examples: airfield



# Examples: airfield

Barricades with sandfilled ISO-containers



# Examples: airfield



RSB (Ready Storage Building)





# Questions?

